MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

DET5088 – ANALOG ELECTRONICS 3

(DEE & DTE)

8 MARCH 2017
9:00 a.m – 11:00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **7** pages (**6** pages with **5** questions and an appendix) excluding cover page.

2. Answer **ALL** questions. All necessary working steps must be shown.

3. Write all your answers in the answer booklet provided.

QUESTION 1 [20 marks]

(a) Describe the basic function of an operational amplifier.

(4 marks)

(b) Given the amplifier circuit in Figure 1 with $R_1 = 20\ \Omega$, $R_2 = 56\ \Omega$, $R_3 = 132\ \Omega$, $R_4 = 345\ \Omega$ with $V_1 = 50\ mV$ and $V_2 = 180\ mV$.

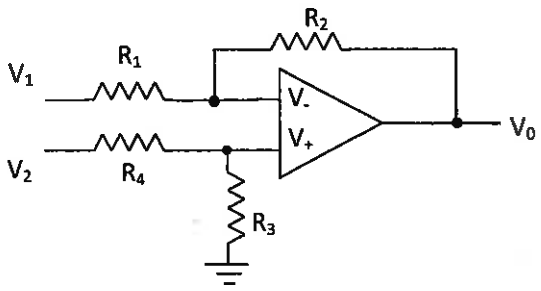


Figure 1

(i) Identify the type of op-amp application in Figure 1.

(1 mark)

(ii) Calculate the output voltage.

(5 marks)

Continued ...

(c) Given the circuit in Figure 2, the $R_1 = 2\ k\Omega$, $R_f = 60\ k\Omega$, $V_{IO} = 10\ mV$, $I_{IO} = 10\ nA$ and $I_B = 100\ nA$

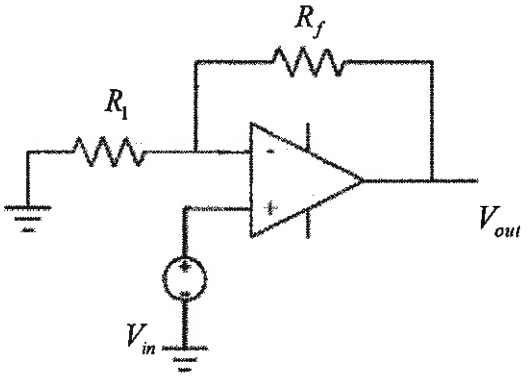


Figure 2

Calculate the output offset voltage, V_{out} due to:

(i) Input Bias Current (2.5 marks)

(ii) Input Offset Current (2.5 marks)

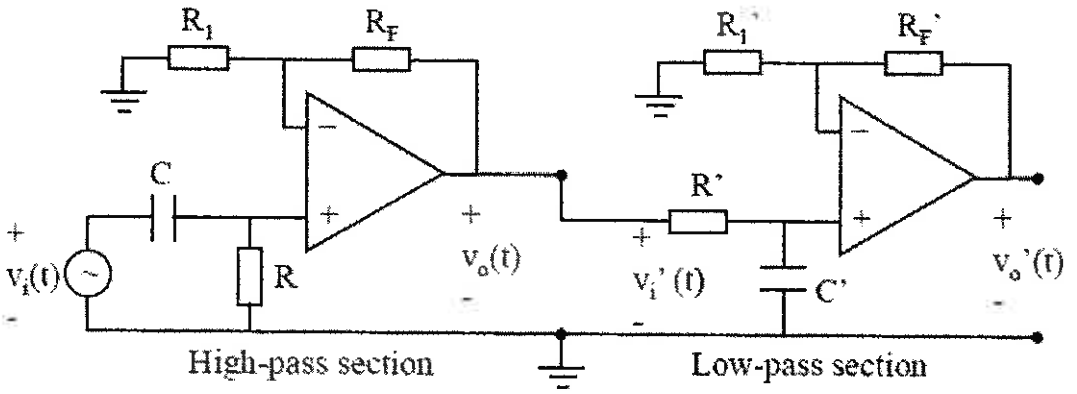
(iii) Input Offset Voltage (2.5 marks)

(iv) Find the Total Output Offset Voltage (2.5 marks)

Continued ...

QUESTION 2 [20 marks]

(a) Given the band pass filter in Figure 3, which has a constant band pass gain of $f_c = 10\ \ kHz$, BW= 100 kHz and $K_{PB} = 4$ with 1st order Low Pass Filter and a 1st order High Pass Filter. Assume $R_F = R_F' = 10\ \ k\Omega$ and $C = C' = 10\ \ nF$, design the filter and find the quality factor (Q) value.



$$f_L = \frac{1}{2\pi RC} \qquad f_H = \frac{1}{2\pi R'C'}$$

$$K_{HP} = 1 + \frac{R_F}{R_1} \qquad K_{LP} = 1 + \frac{R_F'}{R_1'}$$

Figure 3

(20 marks)

Continued ...

QUESTION 3 [20 marks]

(a) Explain briefly the function of a voltage regulator.

(4 marks)

(b) Base on Figure 4, explain the operation of over voltage protection circuit.

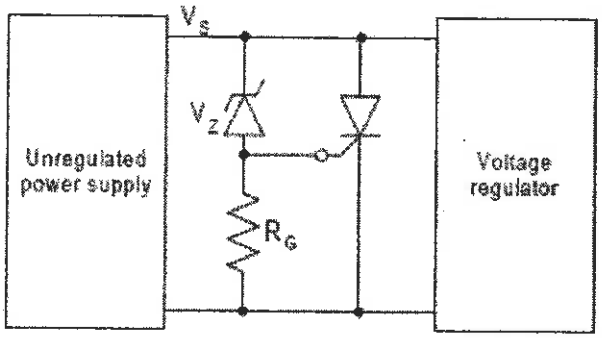


Figure 4

(10 marks)

(c) A voltage regulator circuit has a 50V output when there is no load (I_L= 0A). When there is a full-load current of 88mA, the output voltage is 48.9V. Express the voltage regulation as a percentage change from no-load to full-load and also as a percentage change for each mA change in the load current.

(6 marks)

Continued ...

QUESTION 4 [20 marks]

(a) Define a sinusoidal oscillator and briefly explain its functionality.

(3 marks)

(b) Explain Barkhausen Criterion.

(3 marks)

(c) Design and draw out a phase shift oscillator circuit with a frequency oscillation of 600 Hz. Assume that in the design, $C = 100$ nF and $Rs = 8$ $k\Omega$.

(14 marks)

Continued ...

QUESTION 5 [20 marks]

(a) Define the sampling rate in Analog-to-Digital Converter (ADC) and describe the relationship between sampling rate and the accuracy with aid of diagram.

(6 marks)

(b) Describe the basic operation of the Schmitt Trigger circuit in general and explain how it overcome the problems in comparator.

(4 marks)

(c) Draw an Inverting Schmitt Trigger Comparator with the unequal thresholds, $V_{UTP} \neq V_{LTP}$. Assume V_{ref} is grounded in the circuit. Given $R_{f1} = 75\ k\Omega$, $R_{f2} = 50\ k\Omega$ and $R_1 = 10\ k\Omega$. Then, calculate the V_{UTP}, V_{LTP} and the hysteresis voltage (V_H) for the circuit by assuming that $+V_{out(max)} = +10$ V and $-V_{out(max)} = -10$ V.

(10 marks)

End of Page.

APPENDIX

Biquadratic voltage transfer function

Filter type	k_o, k_1, k_2	Voltage transfer function
Low-pass	1, 0, 0	$H_{LP}(s)=\frac{K\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
High-pass	0, 0, 1	$H_{HP}(s)=\frac{Ks^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-pass	0, 1, 0	$H_{BP}(s)=\frac{K(\omega_o/Q)s}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-reject	1, 0, 1	$H_{BR}(s)=\frac{K(s^2+\omega_o^2)}{s^2+(\omega_o/Q)s+\omega_o^2}$
All-pass	1, -1, 1	$H_{AP}(s)=K\frac{s^2-(\omega_o/Q)s+\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$